MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

DEPARTMENT: CHEMICAL AND PROCESSING ENGINEERING

MODULE: INSTRUMENTATION, PROCESS DYNAMICS AND CONTROL/ PROCESS CONTROL

CODE: CHEP 225/HCHE 322

SESSIONAL EXAMINATIONS
DECEMBER 2022

DURATION: 3 HOURS

EXAMINER: ENG. P. SIGAUKE

INSTRUCTIONS

1. *Answer **ALL FOUR** questions*
2. *Start a new question on a fresh page*
3. *Total marks 100*

Additional material(s): *Calculator*

QUESTION 1

a) A process must satisfy several requirements imposed by its designers and the general technical, economic and social conditions in the presence of ever-changing external influences (disturbances). Explain how a process can satisfy the following requirements:

i) safety of men and machine [5]

ii) environmental regulations [5]

iii) production specifications [5]

iv) operational constraints and economics [5]

(b)Describe and explain any **three** examples of a control system that are encountered in a chemical plant? [5]

QUESTION 2

(a) The role of a process engineer is to ensure continuous operation with safety by monitoring every single process of an industry. List and explain **five** (5) reasons why process control is vital in industry providing industrial examples. [15]

(b) Derive transfer function for first order system, *G(s)* [10]

QUESTION 3

a) Consider a liquid tank of cross-sectional area A in **Fig 1**. The liquid input rate is F_i and the liquid output rate is F_o. The height of the liquid is denoted by h. Derive transfer function for the following tank system [15]

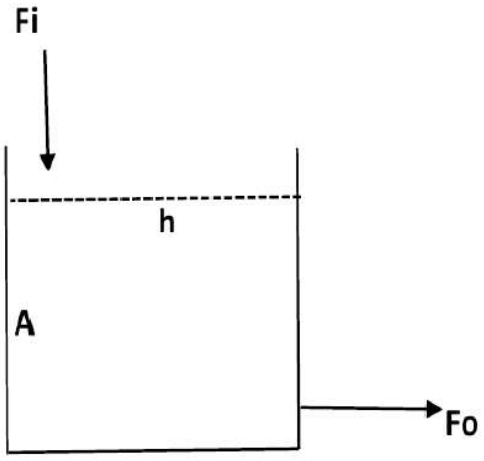

Fig 1

(b) A PID controller is generally used in industrial control applications to regulate temperature, flow, pressure, speed and other process variables.

$$A(s) = K_P e(s) + K_d s + \frac{Ki}{s}$$

Give meaning and formulas for K_d and K_i [5]

c) **Fig. 2** shows the process where liquid is flowing into a tank at some rate, Q_{in} , and out of the tank at some rate, Q_{out}.

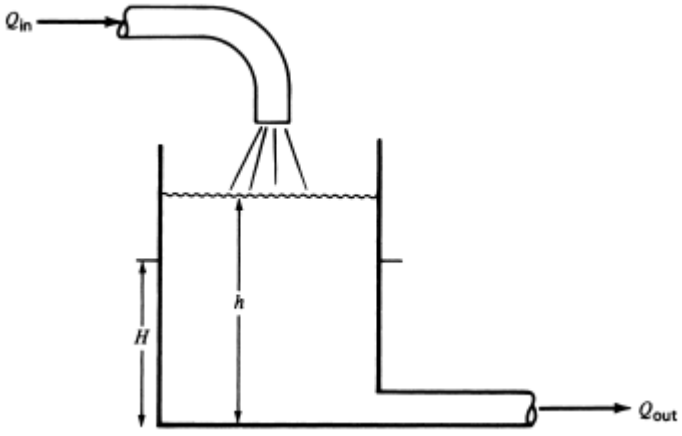

Fig. 2

The liquid in the tank has some height or level, h. It is known that the output flow rate varies as the square root of the height, $Q_{out} = K\sqrt{h}$, so the higher the level, the faster the liquid flows out.

Given that K =1.156 (gal/min)/ft and suppose the input flow is 5 gal/min, at what value of h will the level stabilize from self-regulation? [5]

QUESTION 4

(a)Define the following terms:

i) *manipulated variable* [2]

ii)*Disturbance variable* [2]

iii)*Output variable* [1]

(b) Describe cascade control, and give one concrete example (draw a P&ID)? [10]

(c)Describe and explain the concept of the feedback and feedforward control system using a fully labeled diagram? [10]

END OF EXAMINATION